

WEARABLE SPEAKER GARMENTS

BACKGROUND OF THE INVENTION

This is a Continuation-in-Part of U.S. Serial No. 09/504,265 which is hereby incorporated by reference herein in its entirety.

1. Field of the Invention

This invention relates broadly to audio speakers. More particularly, this invention relates to wearable speakers.

2. State of the Art

Audiophiles and non-audiophiles alike often desire to have music available for listening wherever they may be or whatever they are doing (e.g. while jogging, biking, exercising, or walking). Because of the demand, there exist many portable audio systems designed for personal use, (e.g., Sony Walkman® and similar types of CD and tape players, DVD players, cell phones and other types of signal sources). Most if not all of the portable personal audio systems incorporate the use of headphones or earphones to transmit sound to the listener's ear. However, earphones and headphones are often uncomfortable to wear for long periods of time, are not an attractive fashion statement, can become dislodged as a result of physical activity, and can block or attenuate environmental sounds compromising the wearer's

1 safety. Further, because of size and weight constraints, mounting
2 traditionally sized speakers on clothing would not be feasible.

3
4 U.S. Patent Nos. 5,682,434, 5,815,579, and 5,953,434 all to
5 Boyden attempt to address these problems. U.S. Patent No.
6 5,682,434 discloses a wearable speaker formed by mounting
7 transducers into a thin flat narrow dual cavity structure which
8 can be mounted on a garment of a listener. The speaker enclosure
9 can also be worn like a pendant or collar around the neck of the
10 listener thereby eliminating the need for earphones or headphones.
11 U.S. Patent No. 5,815,579 discloses a wearable speaker adapted to
12 be applied as a collar, yolk, or epaulet of a garment. The
13 enclosure is formed as a thin narrow hollow (or open-celled foam
14 filled) enclosure which may be open to the atmosphere at one or
15 more ends. Likewise, U.S. Patent No. 5,953,434 discloses a thin
16 narrow strip of cloth or open-celled foam having two speakers
17 which is designed to be worn as a head band around the head of a
18 listener. Because of the nature of thin narrow enclosures of the
19 above referenced patents, the speaker chamber volumes formed by
20 the enclosures are necessarily small and thereby provide reduced
21 sound quality from the speakers especially in the lower frequency
22 range. For example, U.S. Patent Nos. 5,815,579 and 5,953,434
23 describe an enclosure structure having a nearly four to one
24 dimensional ratio of width to thickness. Because of the
25 relatively large dimensional ratio of width to thickness of the

1 prior art references, unless the enclosures are formed from
2 substantially rigid materials, the chambers can easily be pinched
3 off (and thereby further reduced in effective size) as the thin
4 narrow enclosures will flex and bend as the wearer moves and
5 flexes and bends the article of clothing. On the other hand, if
6 the enclosures are in fact rigid, they are uncomfortable to wear
7 and will considerably restrict movement of the wearer. Further,
8 the prior art enclosures are designed to be worn as close to the
9 ear of the wearer as possible having the sound transducers
10 positioned such that they direct sound toward the wearer's ear,
11 which may not be a desirable or advantageous placement on a
12 garment.

14 SUMMARY OF THE INVENTION

16 It is therefore an object of the invention to provide a
17 wearable personal speaker system which can be incorporated into a
18 garment e.g, a coat, vest, shirt, tank-top, shawl, t-shirt, scarf,
19 sweater, blouse, pants, or jacket of a wearer.

21 It is another object of the invention to provide a wearable
22 personal speaker system which has a chamber volume sized to
23 enhance low frequency response.

1 It is a further object of the invention to provide a wearable
2 personal speaker system which does not interfere with the activity
3 of the wearer and which does not block environmental sounds.

4
5 It is an additional object of the invention to provide a
6 wearable personal speaker system with enhanced low frequency
7 response which provides a physical sensation to the body of the
8 wearer.

9
10 In accord with these objects, which will be discussed in
11 detail below, a personal speaker system is incorporated into a
12 garment of the wearer. The personal wearable speaker system
13 includes a garment having a plurality of substantially flexible
14 tubular ducts mounted to the garment, and a plurality of pairs of
15 sound transducers mounted to the ducts. The plurality of ducts
16 each have a first end and a second end and each defines a chamber
17 therebetween. Each of the ducts may define a transducer aperture
18 designed to house sound transducers. The ducts each have a first
19 dimension or length, a second dimension or width which is
20 perpendicular to the length, and a third dimension or height which
21 is perpendicular to both the length and the second dimension. It
22 is preferable that the ducts have a width to height ratio of three
23 to one or less to help prevent pinch-off of the chamber.
24 Alternately, the ducts may be provided with one or more undulating
25 surfaces (as disclosed in parent application U.S. Ser. No.

1 09/504,265) which increase flexibility and better prevent pinch-
2 off.

3
4 According to a first embodiment, the garment is a jacket
5 having a front, a back, a pair of shoulders, a pair of sleeves, a
6 wasteband, a pair of zippered pockets near the wasteband, and a
7 collar. The speaker system includes first, second, and third
8 ducts each having a first end and a second end which are mounted
9 to the jacket and each forming a chamber within each of the ducts.
10 The first duct is defined by the collar of the jacket and has a
11 first end and a second end which are closed by the collar. The
12 first ends of the second and third ducts are attached to the front
13 of the jacket, and the second ends of the second and third ducts
14 are attached to the back of the jacket. If desired, each of the
15 second and third ducts may cross one of the shoulders of the
16 jacket. Securing rings coupled to the second and third ducts are
17 preferably used to facilitate the connection between the ends of
18 the ducts and the jacket. The first pair of sound transducers are
19 positioned within the collar such that when the jacket is worn by
20 a wearer, the transducers project sound outward toward an ear of
21 the wearer. Preferably, high frequency sound transducers are
22 mounted in the first duct. In contrast, low frequency sound
23 transducers are positioned within the second and third ducts. In
24 this manner, sound emanating from the front portions of the
25 transducers projects inward toward the body of the wearer and

1 imparts a vibrational component upon the wearer which enhances
2 perception of the low frequency output. Zippered pockets near the
3 wasteband are adapted to receive a player. Wires coupled to the
4 sound transducers run through a lining of the jacket and connect
5 to speaker jacks which connect the sound transducers to the player
6 held within the pocket.

7
8 According to other embodiments of the invention, the speaker
9 system may be provided on other types of garments including a
10 shirt, vest, coat, or on a wearable object such as a backpack.
11 Further, the garment may include any number of ducts adapted to
12 receive any number or size of sound transducers. The ducts may
13 also be formed having any shape, size, or cross-section, provided
14 the dimensional ratio of the ducts is no larger than three to one,
15 or the ducts have a height of at least 0.25 inches, or provided
16 the flexible ducts have one or more undulating front surfaces
17 which allow the ducts to bend and flex with the movement of the
18 wearer without pinching off the chamber. Sound ports may further
19 be provided along the ducts to relieve back pressure within the
20 chambers and to provide a port for dissemination of sound.

21
22 Additional objects and advantages of the invention will
23 become apparent to those skilled in the art upon reference to the
24 detailed description taken in conjunction with the provided
25 figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1a is a perspective view of a front of a first embodiment of a personal wearable speaker system coupled to a garment;

Figure 1b is a perspective view of a back of the first embodiment of the personal wearable speaker system of Figure 1a;

Figure 1c is a cross-sectional view of one duct of Figure 1a taken along line 1c-1c;

Figure 1d is a cross-sectional view of another duct of Figure 1a taken along line 1d-1d;

Figure 1e is a cross-sectional view of a third duct of Figure 1a taken along line 1e-1e;

Figure 2a is a perspective view of a front of a second embodiment of a personal wearable speaker system coupled to a garment;

Figure 2b is a perspective view of a back of the second embodiment of the personal wearable speaker system of Figure 2a;

1 Figure 2c is a cross-sectional view of one duct of Figure 2a
2 taken along line 2c-2c;

3
4 Figure 2d is a cross-sectional view of another duct of Figure
5 2a taken along line 2d-2d;

6
7 Figure 3a is a perspective view of a front of a third
8 embodiment of a personal wearable speaker system coupled to a
9 garment;

10
11 Figure 3b is a perspective view of a back of the third
12 embodiment of the personal wearable speaker system of Figure 3a;

13
14 Figure 4a is a perspective view of a front of a fourth
15 embodiment of a personal wearable speaker system coupled to a
16 garment;

17
18 Figure 4b is a perspective view of a back of the fourth
19 embodiment of the personal wearable speaker system of Figure 4a;

20
21 Figure 4c is a cross-sectional view of a first pair of ducts
22 of Figure 4a taken along line 4c-4c;

23
24 Figure 4d is a broken cross-sectional view of a first pair of
25 ducts of an alternate fourth embodiment;

1 Figure 5a is a perspective view of a front of a fifth
2 embodiment of a personal wearable speaker system coupled to a
3 garment;

4
5 Figure 5b is a perspective view of a back of the fifth
6 embodiment of the personal wearable speaker system of Figure 5a;

7
8 Figure 6a is a perspective view of a front of a sixth
9 embodiment of a personal wearable speaker system coupled to a
10 garment;

11
12 Figure 6b is a perspective view of a back of the sixth
13 embodiment of the personal wearable speaker system of Figure 6a;

14
15 Figure 7a is a perspective view of a front of a seventh
16 embodiment of a personal wearable speaker system coupled to a vest
17 being worn by a wearer;

18
19 Figure 7b is a perspective view of a back of the seventh
20 embodiment of the personal wearable speaker system of Figure 7a
21 being worn by a wearer;

22
23 Figure 7c is a cross-sectional view of a pair of ducts of the
24 seventh embodiment Figure 7a taken along line 7c-7c;

1 Figure 7d is a perspective view of the seventh embodiment of
2 a personal wearable speaker system of Figure 7a wired to an
3 entertainment system.

4
5 Figure 8a is a perspective view of a front of an eighth
6 embodiment of a personal wearable speaker system coupled to a
7 backpack being worn by a wearer;

8
9 Figure 8b is a perspective view of a back of the eighth
10 embodiment of the personal wearable speaker system of Figure 8a
11 being worn by a wearer;

12
13 Figure 9a is a perspective view of a front of an alternate
14 eighth embodiment of a personal wearable speaker system coupled to
15 a backpack being worn by a wearer;

16
17 Figure 9b is a perspective view of a back of the alternate
18 eighth embodiment of the personal wearable speaker system of
19 Figure 9a being worn by a wearer;

20
21 Figure 10a is a perspective view of a front of a ninth
22 embodiment of a personal wearable speaker system coupled to a coat
23 being worn by a wearer;

1 Figure 10b is a perspective view of a back of the ninth
2 embodiment of the personal wearable speaker system of Figure 10a
3 being worn by a wearer; and

4
5 Figure 10c is a cross-sectional view taken along line 10c-10c
6 of Figure 10a.

7
8 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

9
10 Turning now to Figures 1a, 1b, 1c, 1d, and 1e, a first
11 embodiment of a personal wearable speaker system 10 of the
12 invention is shown attached to a garment 12. The speaker system 10
13 has a plurality of tubular ducts 14 coupled to the garment 12, and
14 a plurality of sound transducers 16 coupled to the ducts 14. The
15 garment 12 is a jacket having a front 18 formed as a first front
16 panel 20 and a second front panel 22, a back 24, a pair of
17 shoulders 26 formed at the junction of the front 18 and back 24, a
18 pair of sleeves 28, a wasteband 30, and a collar 32. A zipper
19 type fastener 34 sewn onto the jacket 12 detachably connects the
20 front panels 20, 22. The speaker system 10 includes a first duct
21 14a defining a first chamber 38a, a second duct 14b defining a
22 second chamber 38b, and a third duct 14c defining a third chamber
23 38c. Preferably, the ducts 14a, 14b, 14c are formed from a
24 flexible material such as polyethylene, PVC, or ABS which will
25 allow them to bend and flex with the garment 12 as the garment 12

1 bends and folds so that they are comfortable to wear as a wearer
2 moves. Each of the ducts 14a, 14b, 14c has a first end 40a, 40b,
3 40c and a second end 42a, 42b, 42c. An aperture 44 or hole which
4 receives a transducer 16 is provided at or near each of the ends
5 40, 42 of the ducts. Each of the ducts 14a, 14b, 14c has a set
6 of dimensions including a first dimension or length 46, a second
7 dimension or width 48 which is perpendicular to the length 46, and
8 a third dimension or height 50 which is perpendicular to both the
9 length 46 and the second dimension 48. Each of the ducts 14a,
10 14b, 14c has a width to height ratio of not more than
11 approximately three to one or a height of at least .25 inches.
12 The width to height ratio of the flexible ducts helps prevent the
13 chambers 38a, 38b, 38c from being pinched off as the ducts 14a,
14 14b, 14c bend and flex, thereby preventing an otherwise adverse
15 affect to the sound quality output from the speaker system 10. In
16 the first embodiment of the invention, the width and height
17 dimensions of the first duct 14a are smaller than the width and
18 height dimensions of the second and third ducts 14b, 14c, while
19 ducts 14b, 14c have substantially identical dimensions. In the
20 first embodiment, the dimensions of the first duct 14a are
21 preferably .5 inches by one inch by fifteen inches and the
22 dimensions of the second and third ducts 14b, 14c are preferably
23 one inch by three inches by twenty inches. Transducers of
24 different thicknesses are accommodated by having a raised portion
25 around the driver.

1 According to the first embodiment, the first duct 14a is
2 formed within the collar 32 of the jacket 12, and preferably has a
3 generally circular cross-section as seen in Figure 1d. The second
4 duct 14b and third duct 14c of the speaker system 10 are mounted
5 to an exterior of the jacket 12 such that they both cross from the
6 front 18 to the back 24 of the jacket 12 directly across one of
7 the pair of shoulders 26 of the jacket 12. The second duct 14b
8 and the third duct 14c have substantially rectangular cross-
9 sections with the smaller of the second dimension 48 and third
10 dimension 50 protruding outward from the jacket 12. Further, the
11 second and third ducts 14b, 14c each have a substantially larger
12 cross-sectional area than does the first duct 14a, which allows
13 them to accommodate larger sound transducers 16 within the
14 chambers 38.

15
16 Sound transducers 16, which preferably include face plates or
17 baffle surfaces 39 which are wider than the transducer aperture
18 44, are mounted in the transducer apertures 44 in the ducts 14a,
19 14b, 14c such that at least a portion of each of the sound
20 transducers 16 are contained within the chambers 38 of the ducts
21 14. The sound transducers may be mounted within the transducer
22 apertures by adhesive, double sided tape, pins, clips, or other
23 such devices or mechanisms applied to the face plate 39 such that
24 the transducer is securely held within the aperture even when the
25 flexible duct is bent or flexed. Alternately, the sound

1 transducers may be manipulated into place and secured within the
2 transducer apertures by friction fit.

3
4 According to the first embodiment of the invention, a pair of
5 high frequency sound transducers 16a are preferably mounted in the
6 transducer apertures (not shown) of the first duct 14a, and a pair
7 of low frequency sound transducers 16b are mounted in the
8 transducer apertures 44 of the second and third ducts 14b, 14c.
9 The first pair of sound transducers 16a are mounted in the first
10 duct 14a with the wide portion of the speaker cone opening to the
11 environment so that when the jacket 12 is being worn by a wearer,
12 the soundwaves are projected outwardly toward the ears of the
13 wearer. On the other hand, the sound transducers 16b, 16c mounted
14 in the second and third ducts 14b, 14c are preferably mounted with
15 the wide portion of the speaker cone facing the garment and the
16 wearer so that the sound transducer projects soundwaves inward
17 toward a body of the wearer thereby imparting a low frequency
18 vibrational component of the sound wave to the wearer. The
19 vibratory sensation felt by the wearer has been found to increase
20 the wear's perception of the low frequency sound component of the
21 sound wave. The vibrational component may be enhanced and the
22 sound transducer 16 protected by providing the garment with a
23 perforated membrane 54 at the location on the garment 12 adjacent
24 the sound transducers 16 as seen in Figure 1e.

1 According to the preferred embodiment, decorative covers 56
2 surround the second and third tubular ducts 14b, 14c. The covers
3 56 may be designed to disguise, conceal, or otherwise
4 aesthetically accentuate the ducts 14 as desired. The decorative
5 covers 56 may be formed from any material including a quilted or
6 insulating material which helps direct soundwaves toward the body
7 of the wearer and attenuate any stray soundwaves which might
8 escape outward. Securing rings 58 coupled to the decorative
9 covers 56 surrounding the second and third ducts 14b, 14c near the
10 ends 40b, 40c, 42b, 42c of the ducts 14b, 14c facilitate the
11 connection between the decorative covers 56 and the jacket 12.
12 The securing rings 58 can be detachably coupled to the jacket 12
13 (e.g. by snaps, adhesive, or double-sided tape) such that the
14 decorative covers 56, the ducts 14, and ultimately the sound
15 transducers 16 can be easily removed and reattached when the
16 garment 12 is cleaned. Effectively, then, the system is modular,
17 as sound transducers and/or ducts may be removed and replaced to
18 customize the sound from the system to the particular needs of an
19 individual wearer. Because the first duct 14a is integrally
20 formed with the collar 32 of the jacket 12, it cannot be removed
21 when laundered. Therefore, it is preferable that the first duct
22 14a and the first pair of sound transducers 16a be sealed in a
23 membrane which passes air (sound) and not fluid such as GORTEX or
24 formed from a waterproof material to prevent penetration by
25 moisture. Alternatively, the collar 32 and the duct 14a may be

1 provided with a mating means to facilitate removal of duct 14a and
2 sound transducers 16a.

3
4 The jacket 12 of the first embodiment further includes a pair
5 of pockets 60 near the wasteband 30 at least one of which is sized
6 to hold a portable personal audio tape or CD player (e.g. a Sony®
7 WALKMAN), DVD player, cell phone, or other type of audio source
8 (not shown). The pockets 60, which are concealed within a lining
9 of the jacket, are zippered to allow the wearer to have easy
10 access to the player or other contents. Wires 64 attached to each
11 of the sound transducers 16 run through the lining of the jacket
12 to one of the pockets 60 and electrically connect to speaker jacks
13 (not shown) which couple to the player.

14
15 A second embodiment of a personal wearable speaker system 110
16 which is substantially similar to the first embodiment 10 (with
17 like parts having reference numerals incremented by 100), is shown
18 in Figures 2a, 2b, 2c, and 2d. The second embodiment of the
19 speaker system 110 is shown on a garment 112 and includes three
20 tubular ducts 114a, 114b, 114c coupled to the garment 112, and
21 three pair of sound transducers 116. Each of the ducts 114a,
22 114b, 114c has a first end 140a, 140b, 140c and a second end 142a,
23 142b, 142c, and each defines a chamber 138 therebetween. The
24 sound transducers 116 are mounted in the ends 140b, 140c, and
25 142b, 142c of the first and second ducts 114b, 114c. In the

Sub B2
1 second embodiment, it is preferable that the first duct 114a be
2 smaller than the second and third ducts 114b, 114c and the second
3 and third ducts 114b, 114c be substantially similar in size and
4 shape. The dimensions of the first duct 114a are preferably .5
5 inches by one inch by fifteen inches, and the dimensions of the
6 second and third ducts 114b, 114c are preferably two inches by two
7 inches by twenty inches.

Sub B3
8
9 The first duct 114a of the second embodiment is preferably
10 formed in or on the collar 132 of the jacket 112. The second and
11 third ducts 114b, 114c cross from the front 118 to the back 124 of
12 the jacket 112 across the shoulders 126 of the jacket 112.
13 According to the second embodiment 110, all of the tubular ducts
14 114 are substantially cylindrical and have substantially circular
15 cross-sections along their length 146. Therefore, the width and
16 height dimensions (or tube diameters) of the ducts are
17 substantially equivalent; i.e. each duct 114 may have a one to one
18 width to height ratio. Sound transducers 116 mounted in the open
19 ends 140, 142 in the first duct 114a direct soundwaves outward
20 toward the ears of a wearer. Sound transducers 116 mounted in the
21 open ends 140, 142 of the second and third ducts 114b, 114c
22 project soundwaves inward toward a body of the wearer which
23 imparts a vibrational component to the body of the wearer. The
24 sound transducers 116 are mounted within the open ends 140, 142 of
25 the ducts 114 by adhesive, double sided tape, pins, clips, or

1 or other such device or mechanism applied to the face plate 139
2 such that the transducer is securely held within the open ends
3 even when the flexible duct is bent or flexed. Alternately, the
4 sound transducers may be secured within the ends by friction fit.
5 The vibrational component to the wearer of sound generated by the
6 sound transducers 116 may further be enhanced and the sound
7 transducers 116 protected by providing the jacket 112 with a
8 perforated membrane 154 instead of a fabric lining at the location
9 on the garment 112 adjacent the sound transducers 116. According
10 to the second embodiment, sound ports 170 are defined in both the
11 second and third ducts 114b, 114c near the shoulders 126 of the
12 jacket 112. The sound ports 170 relieve back pressure from within
13 the chambers 138 of the ducts 114 and vent soundwaves outward
14 toward an ear of the wearer. In addition, the sound ports
15 increase the low frequency output of the system.

16
17 As previously suggested, the first duct 114a may be formed
18 into the collar 132 such that it cannot be removed, or may be
19 placed on the collar via a zipper or other mating structure so
20 that it can be removed. Where the first duct is removable, the
21 speaker must either be provided with a receiver and a power source
22 for wireless transmission from the player or wire contacts must be
23 established at the mating structure to establish a connection
24 between the player and the speaker. For example, a zipper half on
25 the jacket may be electrically wired to the player and the zipper

1 half on the removable collar section may be electrically wired to
2 the speaker such that contact is established when the collar is
3 attached to the jacket. In stereo, each zipper portion may be
4 divided into two sections by a non-conductive tooth or set of
5 teeth such that separate wires are run from the separate speakers
6 to the separate zipper sections on the removable collar, and from
7 the player to the separate sections of the jacket zipper portion.

8
9 The second and third ducts 114b, 114c are preferably
10 detachably coupled to the jacket 112 by securing rings 158 coupled
11 to the ducts 114 near the ends 140b, 140c, 142b, 142c of the ducts
12 114b, 114c. The securing rings 158 are secured to the ducts 114b,
13 114c via stitches, adhesives, double-sided tape or other securing
14 mechanisms. The securing rings 158 are coupled to the jacket 112
15 (e.g. by stitches, adhesive, or double-sided tape) such that the
16 ducts 114 and ultimately the sound transducers 116 can be easily
17 removed and reattached. Further, the jacket 112 of the second
18 embodiment preferably has a pair of external pockets 160 near the
19 wasteband 130. The pockets 160 are preferably gusseted so that
20 they can expand to provide extra room to hold larger personal
21 audio systems or a larger number of CDs or cassettes. The pockets
22 160 have a flap 172 with a snap closure to secure the contents of
23 the pockets 160 and to provide quick access to the audio player.
24 Wires 166 attached to each of the sound transducers 116 run inside
25 a lining of the jacket and terminate in jacks (not shown) which

1 electrically connect the sound transducers 116 to the audio
2 player.

3
4 Turning now to Figures 3a and 3b, a third embodiment of a
5 wearable speaker system 210, which is substantially similar to the
6 first embodiment 10 (with like parts having reference numerals
7 incremented by 200), is shown. The third embodiment of the
8 speaker system 210 includes a garment 212 having three tubular
9 ducts 214a, 214b, 214c coupled to the garment 212, and three pairs
10 of sound transducers (not shown) coupled to the ducts 214.

11 According to the third embodiment, the first duct 214a is formed
12 and positioned on the jacket 212 similarly to the first duct 14a
13 in the first embodiment 10. The third duct 214c is positioned
14 across a shoulder 226 of the jacket 212 as described in previous
15 embodiments. However, according to the third embodiment 210, the
16 second duct 214b is positioned upon the jacket 212 such that it
17 crosses from the first front panel 220 of the front 218 of the
18 jacket 212 to the back 224 of the jacket 212 substantially beneath
19 one of the pair of sleeves 228. The second and third ducts 214b,
20 214c have a first end 240b, 240c and a second end 242b, 242c and
21 both define a chamber (not shown) therebetween. Further the ends
22 of both the second and third ducts 214b, 214c either constitute or
23 have defined therein a pair of transducer apertures (not shown)
24 which open to the chambers. The transducer apertures and
25 therefore the sound transducers can be advantageously positioned

1 over particularly sensitive body organs (e.g. liver, kidneys,
2 chest cavity) to enhance the vibratory response to the wearer.
3 Further, according to the third embodiment 210, the first ends
4 240b, 240c of the second and third ducts 214b, 214c are larger
5 than the second ends 242b, 242c to accommodate a larger low
6 frequency sound transducer which provides an enhanced vibrational
7 component. As with the previous embodiments, all of the ducts 214
8 of the third embodiment 210 preferably maintain a width to height
9 ratio of no more than three to one.

10
11 According to the third embodiment 210, the jacket 212 is
12 preferably provided with three zippered pockets 260, which are
13 substantially concealed between the lining (not shown) and the
14 outer surface of the jacket 212. The pockets 260 are positioned
15 about the front 218 of the jacket 212 and include an upper pocket
16 near the collar 232 and two lower pockets near the wasteband 230.
17 As with previous embodiments, wires (not shown) attached to each
18 of the sound transducers run inside the lining (not shown) of the
19 jacket and electrically connect the sound transducers to the audio
20 player. Each of the pockets 260 may be wired independently to
21 provide multiple storage options for the audio player, giving the
22 wearer the option of placing the audio player within the upper
23 pocket thereby leaving the lower pockets near the wasteband 230
24 free to protect the wearer's hands or wallet. Alternately, just
25 one of the pockets is selected for wiring.

1 A fourth embodiment of a personal wearable speaker system 310
2 coupled to a garment, which is substantially similar to the first
3 embodiment 10 (with like parts having reference numerals
4 incremented by 300), is shown in Figures 4a, 4b, and 4c. The
5 fourth embodiment of the speaker system 310 includes the garment
6 312 having five tubular ducts 314a, 314b, 314c, 314d, 314e coupled
7 to the garment 312, and five pairs of sound transducers 316, one
8 pair of which is coupled to each of the ducts 314. As with the
9 previous embodiments, the garment 312 of the fourth embodiment 310
10 is preferably a jacket 312 having a front 318 formed as a pair of
11 front panels 320, 322, a back 324, a pair of shoulders 326 formed
12 at the junction of the front 318 and back 324, a pair of sleeves
13 328, a wasteband 330, and a collar 332. According the fourth
14 embodiment 310, each of the tubular ducts 314 has a first end
15 340a, 340b, 340c, 340d, 340e and a second end 342a 342b, 342c,
16 342d, 342e and each defines a chamber (not shown) therebetween.
17 Further, each of the ducts 314 defines a transducer aperture (not
18 shown) near or at each of the ends 340, 342 which opens into the
19 chambers.

20
21 Each of the ducts 314 of the fourth embodiment is has
22 substantially circular cross-sections along its length, thereby
23 providing a width to height ratio of one to one for the ducts. In
24 the fourth embodiment 310, it is preferable that the dimensions of
25 the second 314b, third 314c, fourth 314d, and fifth 314e ducts be

1 the same. The dimensions of the first duct 314a are preferably .5
2 inches by one inch by fifteen inches, the dimensions of the second
3 and third ducts 314b, 314c, are preferably .75 inches by .75
4 inches by twenty inches, and the fourth, and fifth ducts 314d,
5 314e are preferably .75 inches by .75 inches by twenty-five
6 inches.

7

8 According to the fourth embodiment 310, the first tubular
9 duct 314a is formed by a collar 332 of the jacket 312 as described
10 in previous embodiments. The four remaining tubular ducts 314b,
11 314c, 314d, 314e of the fourth embodiment are applied to the
12 jacket 312 in pairs 314b, 314c and 314d, 314e. A first pair 314b,
13 314c are held in substantially parallel relation, and cross from
14 the first front panel 320 to the back 324 over one shoulder 326 of
15 the jacket 312. The other pair of ducts 314d, 314e, which are
16 also held in substantially parallel relation, cross from the
17 second front panel 322 to the back 324 across the other shoulder
18 326. As with previous embodiments, a sound transducer is mounted
19 to each of the transducer apertures. The sound transducers are
20 sized such that at least a portion of the transducer is housed
21 within each of the chambers of the ducts 314. The sound
22 transducers within the first duct 314a are preferably adapted to
23 project a sound wave outward toward the ears of a wearer. Sound
24 transducers within the other ducts 314b, 314c, 314d, 314e are
25 positioned such that when the jacket 312 is being worn by a

1 wearer, the sound transducers project soundwaves toward the body
2 of the wearer thereby imparting a vibratory sensation to the body
3 of the wearer. As described in a previous embodiment, the precise
4 positioning of the transducers and the ducts may be influenced by
5 the desire to locate the sound transducers near specific sensitive
6 body organs which will enhance the vibratory response. However,
7 it will be appreciated that the location of the sound transducers
8 and therefore the ducts 314 on the garment 312 may also be totally
9 or partially influenced by aesthetics, i.e., it may be
10 aesthetically desirable to either position some of the plurality
11 of ducts 314 adjacent one another or instead randomly place them
12 about the jacket 312 such that they crisscross. Further, the
13 vibrational component may be enhanced and the sound transducer
14 protected by providing the jacket with a perforated membrane 354
15 at the locations on the jacket adjacent the sound transducers. As
16 with previous embodiments, securing rings 358 coupled to the ducts
17 314b, 314c, 314d, 314e near the ends 340b, 340c, 340d, 340e, and
18 342b, 342c, 342d, 342e may be used to facilitate the connection
19 between the ends 340b, 340c, 340d, 340e, and 342b, 342c, 342d,
20 342e and the jacket 312. Alternately or additionally, decorative
21 securing strips 376 may be attached to the jacket 312 across the
22 ducts 314b, 314c, 314d, 314e to both secure the ducts to the
23 jacket and to provide an aesthetic element to the design of the
24 garment.

1 In an alternate fourth embodiment shown in Figure 4d, either
2 the first pair 314b, 314c or second pair of tubular ducts (not
3 shown) may be coupled to the sound transducer 316 such that the
4 pair is coupled to only one sound transducer 316 which is adapted
5 to sit adjacent the pair of ducts. The single transducer 316 can
6 thereby utilize both chambers 338b, 338c effectively creating a
7 dual chambered speaker enclosure.

8
9 The jacket 312 of the fourth embodiment 310 further includes
10 a snap or button front fastener 334 and has no external pockets.
11 Instead, an internal pocket (not shown) is provided to house the
12 audio player. As previously described, wires (not shown) attached
13 to each of the sound transducers run through a lining of the
14 jacket and electrically connect the sound transducers to the
15 player.

16
17 Turning now to Figures 5a and 5b, a fifth embodiment of a
18 personal wearable speaker system 410 coupled to a garment 412,
19 which is substantially similar to the first embodiment 10 (with
20 like parts having reference numerals incremented by 400), is
21 shown. The fifth embodiment of the speaker system 410 includes a
22 garment 412 having a pair of cylindrical tubular ducts 414a, 414b
23 coupled to the garment 412, and two pair of sound transducers (not
24 shown) coupled to the ducts 414. The garment 412, which is
25 preferably a vest or a shirt, includes a front 418 formed as a

1 pair of front panels 420, 422 defining a front opening 478 in the
2 garment 412, a back 424, a pair of shoulders 426 formed at the
3 junction of the front 418 and back 424, a pair of sleeves 428, and
4 a collar 432. A pair of hook and loop type fasteners 434 (e.g.
5 VELCRO strips) sewn onto the front panels 420, 422 detachably
6 connect the front panels 420, 422 and secure the front opening
7 478. According to the fifth embodiment, each of the tubular ducts
8 414a, 414b has a first end 440a, 440b and a second end 442a, 442b
9 and each defines a chamber (not shown) within the ducts 414.
10 Further, each of the ducts 414 defines a transducer aperture (not
11 shown) at or near each of the ends 440 which opens into the
12 chambers. As with the previous embodiments, each of the tubular
13 ducts 414 has a length, a width, and a height, and a width to
14 height ratio preferably of not more than three to one. Because
15 the tubular ducts 414 of the fifth embodiment 410 are
16 substantially cylindrical, the second and third dimensions are
17 substantially equivalent thereby providing a one to one width to
18 height ratio. In the fifth embodiment 410, it is preferable that
19 the dimensions of the first and second ducts 414a, 414b be
20 identical. Preferred dimensions are 1.5 inches by 1.5 inches by
21 twenty-five inches.

22
23 A sound transducer is mounted within each of the transducer
24 apertures in the ducts. Further, each of the tubular ducts 414
25 defines a plurality of sound ports 470 spaced along its length.

1 As previously described in the first embodiment, both ducts 414a,
2 414b cross from the front 418 to the back 424 of the garment 412
3 across a shoulder 426 of the garment 412. Each of the ducts 414a,
4 414b of the fifth embodiment 410 are positioned on the garment 412
5 such that the first ends 440a, 440b align centrally upon one of
6 the front panels 420, 422. The second ends 442a, 442b of the
7 ducts 414 are centrally located and aligned on opposing sides of a
8 centerline 482 of the back 424 of the garment 412. The centerline
9 482 also corresponds to a location adjacent a spinal column of a
10 wearer. As previously described, securing rings 458 attach near
11 the ends 440a, 440b, 442a, 442b of the ducts 414a, 414b and help
12 detachably secure the ducts 414a, 414b to the garment 412. As
13 shown in Figure 5b, a single securing ring 458 secures both second
14 ends 442a, 442b of the ducts 414a, 414b to the garment 412. In
15 the fifth embodiment 410, no pocket or other carrying aid is
16 provided to accommodate the audio player. The player can instead
17 be held by the wearer or otherwise secured to another garment of
18 the wearer. Wires 466a, 466b, 466c, and 466d are attached to the
19 sound transducers, run along an inside of the back 424 of the
20 garment 412, and electrically connect the sound transducers to the
21 player which is located elsewhere.

22
23 As seen in Figures 6a and 6b, a sixth embodiment of a
24 personal wearable speaker system 510 coupled to a garment 512,
25 which is substantially similar to the first embodiment 10 (with

1 like parts having reference numerals incremented by 500), is
2 shown. The sixth embodiment of the speaker system 510 includes a
3 garment 512 having four tubular ducts 514a, 514b, 514c, 514d
4 coupled to the garment 512 in pairs (514a, 514b & 514d, 514d), and
5 four pairs of sound transducers (not shown) coupled to the ducts
6 514. The garment 512 is preferably a vest or shirt similar to the
7 garment in Figures 5a and 5b. The four substantially cylindrical
8 tubular ducts 514a, 514b, 514c, 514d each have a first end 540a,
9 540b, 540c, 540d and a second end 542a, 542b, 542c, 542d defining
10 a chamber (not shown) and each defining a pair of transducer
11 apertures (not shown) opening into the chamber. As with the
12 previous embodiments, the tubular ducts 514 of the sixth
13 embodiment 510 preferably maintain a width to height ratio of no
14 more than three to one. In the sixth embodiment 510, it is
15 preferable that the dimensions of each of the ducts 514a, 514b,
16 514c, 514d be equivalent. The dimensions of the ducts 514 are
17 preferably .75 inches by .75 inches by twenty inches. As with the
18 fourth embodiment, the first pair of ducts 514a, 514b are aligned
19 in a substantially parallel relation and cross from the first
20 front panel 520 to the back 524 of the garment 512 across one
21 shoulder 526 of the garment 512. The second pair of ducts 514c,
22 514d are also aligned in a substantially parallel relation and
23 cross from a second front panel 522 to the back 524 of the garment
24 512 across another shoulder 526 of the garment 512.

25

1 Sound transducers are at least partially housed within the
2 transducer apertures such that soundwaves emanating therefrom are
3 projected toward a body of a wearer enhancing the low frequency
4 response. The vibrational component may be further enhanced by
5 providing a perforated membrane at the locations on the garment
6 adjacent the sound transducers. Sound ports 570, defined by the
7 ducts 514 near the shoulders 526 of the garment 512, help relieve
8 back pressure within the chambers and also project soundwaves
9 outward toward an ear of the wearer. As in the fourth embodiment
10 310, securing strips 576 sewn onto the garment 512 about each of
11 the pair of ducts 514a, 514b, and 514c, 514d may be used to secure
12 the ducts to the garment 512 and/or may be used primarily for
13 aesthetic decoration. As in the fifth embodiment 410, the garment
14 510 does not have a pocket to hold an audio player. Instead wires
15 566a, 566b, 566c, and 566d attached to each of the sound
16 transducers run along an inside of the back 524 of the garment 512
17 and electrically connect the sound transducers to the player which
18 is preferably contained elsewhere on the person of the wearer.

19 -

20 Turning now to Figures 7a, 7b, 7c, and 7d, a seventh
21 embodiment of a personal wearable speaker system 610 coupled to a
22 garment, which is substantially similar to the first embodiment 10
23 (with like parts having reference numerals incremented by 600), is
24 shown. The speaker system 610 includes a garment 612, two pair of

1 relatively flat ducts 614a, 614b, and 614c, 614d attached to the
2 garment 612, and a plurality of sound transducers 616 coupled to
3 the ducts 614. According to the seventh embodiment, the
4 relatively flat ducts are preferably formed as open back ducts
5 which are preferably provided with undulating surfaces 619 as
6 disclosed in previously incorporated U.S. Serial No. 09/504,265 to
7 Wiener. Preferably, the open back ducts are coupled in pairs to
8 mating receptacles 615a, 615b (better shown in Figure 7c) attached
9 to the garment. With an open back duct, the garment and the duct
10 together define a chamber therebetween. The paired multichannel
11 ducts (i.e., one channel per duct) provide separate chambers for
12 separate high and low frequency transducers. In the seventh
13 embodiment, the ducts 614 may be formed into any shape or size and
14 may vary in cross-sectional shape along their length. The
15 undulating surfaces 619 aid sound flow through the chambers and
16 prevent chamber pinch off. Where the flexible ducts are provided
17 with undulating surfaces, there is no need to limit the width to
18 height to a maximum 3:1 ratio for each of the ducts, as the
19 undulations help prevent the ducts from being pinched off.

20
21 According to the seventh embodiment 610, the garment 612 is a
22 vest having a front 618 formed as a pair of front panels 620, 622
23 defining an opening 678 therebetween, a back 624, a pair of
24 shoulders 626 formed at the junction of the front 618 and the back
25 624, and a pair of pockets 660 each attached to one of the pair of

1 front panels 620, 622. Each of the ducts 614a, 614b, 614c, 614d
2 has a first end 640a, 640b, 640c, 640d and a second end 642a,
3 642b, 642c, 642d and each defines a chamber 638a, 638b, 638c, 638d
4 between the duct and the garment. Further, each of the ducts 614
5 define at least one transducer aperture 644b, 644c (644a, 644d not
6 shown) which opens into the chambers 638.

7
8 According to the seventh embodiment 610, the ducts 614 are
9 preferably mounted to the vest in pairs 614a, 614b, and 614c, 614d
10 each pair having an innermost duct 614b, 614c and an outermost
11 duct 614a, 614d (relative to the neck). Each pair of ducts
12 directly crosses one of the shoulders 626 of the vest from the
13 front 618 to the back 624 such that the first ends 640 are coupled
14 to one of the front panels 630, 622 and the second ends 642 are
15 coupled to the back 624. Although preferably attached to the
16 garment by receptacles, the ducts may instead attach by being
17 sewn, snap fastened, or being seated in/on a retaining grommet.
18 The two pair of ducts may be integrally formed as shown or may be
19 independent of one another. Transducer apertures 644a, 644b are
20 defined in the innermost ducts 614b, 614c near the shoulders 626
21 of the garment 612. Transducer apertures (not shown) are defined
22 in the outermost ducts 614a, 614d directly above particular body
23 organs. Sound transducers 644a, 644b mounted within the innermost
24 ducts 614b, 614c project sound outward toward the ears 688 of the
25 wearer 690. Sound transducers in the outermost ducts 614a, 614d

1 are mounted in the transducer apertures directly above
2 particularly sensitive body organs to provide a vibrational
3 component to a body 693 of the wearer 690 which enhances the
4 perception of the low frequency sound component. Additionally,
5 the vibrational component may be enhanced and simultaneously the
6 sound transducer protected by providing the garment fabric with a
7 perforated membrane 654 at the location on the garment 612
8 adjacent the sound transducers. The pair of external pockets 660
9 provided on the front 618 of the vest 612 are adapted to house an
10 audio player. However, it is understood that the player may
11 instead be carried by the wearer 690 or be secured to another
12 article of clothing. Wires 666 attached to each of the sound
13 transducers 616 run along an inside of the vest 612 or within an
14 internal lining of the vest and electrically connect the sound
15 transducers 616 to the audio player.

16
17 If desired, a duct 614e with a pair of sound transducers 686
18 attached thereto may be provided on a headband 684 adapted to be
19 worn about a head 685 of a wearer 690. The sound transducers are
20 aligned adjacent one of the ears 688 of the wearer 690. A wire
21 692, which runs adjacent the head 685 of the wearer 690 down to
22 the shoulder 626 of the vest 612, is provided to electrically
23 connect the sound transducers 686 on the headband 684 to the
24 player contained on the vest 612. Referring specifically to
25 Figure 7d, the speaker system 610 may instead be wired to an

1 audio/video device 694 (e.g. a television) to provide personal
2 stereophonic sound while the wearer 690 is viewing a video display
3 and/or listening to music.
4

5 Turning now to Figures 8a and 8b, an eighth embodiment of a
6 personal wearable speaker system 710 coupled to a backpack 712,
7 which is substantially similar to the seventh embodiment 610 (with
8 like parts having reference numerals incremented by 100), is
9 shown. The speaker system 710 includes the backpack 712, two
10 relatively flat ducts 714a, 714b having undulating surfaces 719
11 and being coupled to the backpack 712, and a pair of sound
12 transducers 716a, 716b coupled to each of the ducts 714a, 714b.
13 According to the eighth embodiment, the backpack 712 has a front
14 718, a back (not shown), and a pair of sides 796a, 796b, and
15 defines a zippered compartment (not shown) substantially
16 therebetween. Further, the backpack 712 has a pair of straps
17 799a, 799b. Each of the tubular ducts 714a, 714b attach to the
18 front 718 of the backpack 712. Each duct 714a, 714b has a first
19 end 740a, 740b and a second end 742a, 742b and defines a chamber
20 (not shown) therebetween. The ducts 714a, 714b further define a
21 pair of transducer apertures (not shown) which open to the
22 chambers. The first transducer aperture is defined near the first
23 end 740 of the ducts 714 and is adapted to house a high frequency
24 sound transducer 716a. The second transducer aperture is defined
25 near the second end 742 is adapted to house larger low frequency

1 transducers 716b. A sound transducer 716 is mounted to each of
2 the transducer apertures such that soundwaves from the high
3 frequency transducers 716a project outward toward an ear 788 of a
4 wearer 790 and soundwaves from the low frequency transducers 716b
5 project soundwaves inward toward a body 793 of the wearer 790.
6 The zippered compartment (not shown) is adapted to house an audio
7 player. Wires (not shown) attached to each of the sound
8 transducers 716a, 716b connect to speaker jacks which run along an
9 inside of the backpack 712 and electrically connect the sound
10 transducers to the player contained therein.
11

12 If desired, the backpack of Figure 8a and 8b, as shown in an
13 alternate eighth embodiment 710 shown in Figures 9a and 9b, can be
14 provided with straps 799a, 799b which are themselves provided with
15 a duct 714 and a transducer 716. The ducts 714 may be tubular or
16 have undulating surfaces 719 as described previously.
17

18 A ninth embodiment of a personal wearable speaker system 810
19 coupled to a garment, which is substantially similar to the
20 seventh embodiment 610 (with like parts having reference numerals
21 incremented by 200), is shown in Figures 10a, 10b, and 10c. The
22 speaker system 810 includes a garment 812, a plurality of
23 relatively flat ducts 814a attached to the garment 812, a pair of
24 tubular ducts 814b coupled elsewhere to the garment 812, and a
25 plurality of sound transducers 816 each coupled to one of the

1 ducts 814a, 814b. According to the ninth embodiment 810, the
2 garment 812 is a coat having a front 818 formed as a first front
3 panel 820 and a second front panel 822, a back 824, a pair of
4 shoulders 826 formed at a junction of the front 818 and back 824,
5 a pair of sleeves 828 and a collar 832. Buttons, a zipper, or
6 other type of fastener (not shown) may detachably couple the front
7 panels 820, 822. The garment 812 may also be provided with
8 interior and/or exterior pockets 860. The relatively flat ducts
9 814a are preferably formed as open back ducts which are preferably
10 provided with undulating surfaces 819. The open back ducts 814a
11 form substantially hollow chambers 838 when mated with the
12 exterior surface 817 of the garment 812. The ducts 814a may be
13 formed into any shape or size and may vary in cross-sectional
14 shape along their length. The undulating surfaces 819 aid sound
15 flow through the chambers and prevent chamber pinch off. Because
16 the ducts are provided with undulating surfaces, there is no need
17 to provide the preferred width to height ratio of no more than
18 three to one for each of the ducts, as the undulations help
19 prevent the ducts from being pinched off. The ducts 814a are
20 preferably coupled to receptacles 815 which are coupled to the
21 garment 812 as disclosed in the parent application hereto.

22
23 As previously mentioned, the ducts 814a are preferably
24 attached to an exterior surface 817 of the garment. The ducts
25 814b are preferably attached at the collar 832 and may be run

1 either within the lining (not shown) of the garment 812 or along
2 an interior surface (not shown). The ducts 814b may be tubular or
3 any other shape which preferably maintains a width to height ratio
4 of no greater than three to one in regions where the ducts 814b
5 are most likely to be pinched off. As discussed in previous
6 embodiments, the ducts 814a may be arranged on the garment such
7 that some ducts 814a are completely on either one of the front
8 panels 820, 822 or the back 824 of the coat 812. Alternatively,
9 some of the ducts 814a may cross one of the shoulders 826 of the
10 garment 812. Transducers 816 may be positioned in the ducts 814a
11 such that they either face outward or inward as desired.
12 Transducers 816 coupled to the tubular ducts 814b are preferably
13 positioned such that they project sound upward toward an ear of a
14 wearer. Wires 866 may be run from each of the transducers through
15 a lining of the coat 812 to one of the pockets 860 which is
16 preferably designed to house a player.

17
18 There have been described and illustrated herein several
19 embodiments of a personal wearable speaker system. While
20 particular embodiments of the invention have been described, it is
21 not intended that the invention be limited thereto, as it is
22 intended that the invention be as broad in scope as the art will
23 allow and that the specification be read likewise. While
24 particular types of garments have been disclosed, it will be
25 understood that the personal wearable speaker system may be

1 applied to other types of garment as well; for example, and not by
2 way of limitation, pants, shirts, blouses, t-shirts, sweat shirts,
3 tank-tops, shawls, scarves, sweater, and capes. Likewise, while
4 garments having a front formed by two front panels were disclosed,
5 it will be appreciated that a garment may instead have a single
6 front panel. While particular types of players have been
7 disclosed, it will be appreciated that other types of sound
8 sources could be adapted for use with this system as well.
9 Further, while the transducers and the player are described as
10 being wired together, it will be appreciated that the signal from
11 the player may be received by other "wireless" means. It will
12 also be appreciated that the ducts and sound transducers may be
13 interchangeable modular features which a wearer buys, installs,
14 and replaces at different times to customize the personal wearable
15 sound system and that only one duct housing one transducer need be
16 provided. Moreover, while particular duct arrangements on a
17 particular type garment were disclosed, it will be appreciated
18 that similar type garments could have one or more ducts arranged
19 differently. Also, while externally mounted tubular ducts have
20 been disclosed, it will be appreciated that the personal wearable
21 speaker system could instead be provided with internally mounted
22 ducts. Moreover, while ducts having particular dimensional size,
23 shape or cross-section have been disclosed, it will be appreciated
24 that ducts having different dimensional sizes, shapes, or cross-
25 sections may likewise be used. It will likewise be appreciated

1 that each of the ducts in a speaker system may have a different
2 size, shape, or cross-section from all other ducts in the system.
3 Further, it will be appreciated that the cross-section of any of
4 the ducts may change along a length of the ducts. While
5 substantially flat flexible ducts having undulating front surfaces
6 and open backs were disclosed, it will be appreciated that the
7 substantially flat ducts may be formed having closed backs as long
8 as at least a portion of the duct most subjected to punch-off
9 forces has undulations. Additionally, it will be appreciated that
10 the tubular ducts may be used in combination with the
11 substantially flat ducts on the same garment. It will also be
12 appreciated that at least a portion of the ducts need not be
13 flexible. While particular means of attachment of the ducts to
14 the garment have been disclosed, it will be appreciated that other
15 attachment means may be utilized as well including but not limited
16 to adhesive, quick-release hardware, and magnets. Further, it
17 will be appreciated that the ducts may be adapted to house one or
18 more sound transducers. Also, sound transducers can include but
19 are not limited to speaker drivers having a cone and magnet and
20 membrane speakers. Furthermore, while it is preferred that the
21 high frequency sound transducers be mounted near an ear of a
22 wearer, it will be appreciated that the high frequency sound
23 transducers may be mounted anywhere on the system. It will
24 therefore be appreciated by those skilled in the art that yet

- 1 other modifications could be made to the provided invention
- 2 without deviating from its spirit and scope as claimed.